

ISTA, Your Alliance in Transport Packaging, is the world leader in Performance Tests for Packaged-Products.

ISTA 3 Series tests are advanced tests.

- They challenge the capability of the package and product to withstand transport hazards, **but**
- They use general simulation of actual transport hazards, **and**
- They do not necessarily comply with carrier packaging regulations.

When properly applied, ISTA procedures will provide tangible benefits of:

- Shortened packaged development time and confidence in product launch
- Protection of products and profits with reduced damage and product loss
- Economically balanced distribution costs
- Customer satisfaction and continued business.

There are three sections: Overview, Testing and Report

- **Overview** provides the general knowledge required before going into the testing laboratory **and**
- **Testing** presents the specific instructions to do the testing in the laboratory **and**
- **Report** indicates what data shall be recorded to submit a test report to ISTA.

Two systems of weights and measures are presented in ISTA test procedures. They are the English system (Inch-Pound) and the international system SI (Metric). Inch-Pound units are shown first with Metric units in brackets, except in some tables where they are shown separately.

- Either system may be used as the unit of measure (standard units), **but**
- The standard units chosen shall be used consistently throughout the procedure.
- Units are converted to two significant figures **and**
- Not exact equivalents.

VERY IMPORTANT:

The entire document shall be read and understood before proceeding with a test.

OVERVIEW OF PROCEDURE 3E

Preface

Test Procedure 3E is a general simulation test for unitized loads of the same retail or institutional packaged-products. A unitized load is defined as one or more products or packaged-products usually on a skid or pallet, but always secured together or restrained for distribution as a single load. Examples would be a stretch wrapped pallet load of individual containers, a single non-packaged machine banded to a pallet and a pallet with a corrugated tray, tube and a cap.

- It can be used to evaluate the protective performance of packaged-products related to vibrations, shocks and other stresses normally encountered during handling and transportation.
- It can be used to evaluate load stability.
- The test levels are based on general data and may not represent any specific distribution system.
- The package and product are considered together and not separately.
- Some conditions of transit, such as moisture, pressure or unusual handling, may not be covered.

Other ISTA Procedures may be appropriate for different conditions or to meet different objectives.

Specific suggestions:

- To test the individual packaged-product that might be shipped non-unitized from a distribution center to a retail outlet, use ISTA Test Procedure 3F.
- Refer to *Guidelines for Selecting and Using ISTA Procedures and Projects* for additional information.

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OVERVIEW OF PROCEDURE 3E

Scope

Test Procedure 3E covers testing of unitized loads, made up of either single or multiple products or packages of the same products.

Product Damage Tolerance and Degradation Allowance

The shipper shall determine the following prior to testing:

- What constitutes damage to the product **and**
- what damage tolerance level is allowable, if any, **and**
- the correct methodology to determine product condition at the conclusion of the test **and**
- the acceptable package condition at the conclusion of the test.

For additional information on this determination process refer to *Guidelines for Selecting and Using ISTA Procedures and Projects*.

Samples

Samples should be the untested actual package and product, but if one or both are not available, the substitutes shall be as identical as possible to actual items.

Number of samples required:

One sample (unitized load) is required for the tests in this procedure.

Replicate Testing Recommended:

To permit an adequate determination of representative performance of the packaged-product, ISTA:

- Requires the procedure to be performed one time, **but**
- Recommends performing the procedure five or more times using new samples with each test.

NOTE:

Packages that have already been subjected to the rigors of transportation cannot be assumed to represent standard conditions. In order to insure testing in perfect condition, products and packages shipped to certified laboratories for testing must be:

- over-packaged for shipment to the laboratory **or**
- repackaged in new packaging at the laboratory.

Test Sequence

The tests shall be performed on each test sample in the sequence indicated in the following table:

Sequence #	Test Category	Test Type	Test Level	For ISTA Certification
1	Atmospheric Preconditioning	Temperature and Humidity	Ambient	Required
2	Atmospheric Conditioning	Controlled Temperature and Humidity	Temperature and humidity chosen from chart	Optional
3	Shock	Incline (Conbur)	42 inches per second (1.1 meters per second)	Required
		Alternative Horizontal Impact	42 inches per second (1.1 meters per second)	
4	Shock	Rotational Edge Drop	8 inches (200 mm)	Required
5	Compression	Machine Apply and Release	Calculated Test Load x 1.4	Required
		Machine Apply and Hold	Calculated Test Load	
		Weight and load Spreader	Calculated Test Load	
6	Vibration	Random	Overall G_{rms} level of .52	Required
7	Shock	Rotational Edge Drop	8 inches (200 mm)	Required

EQUIPMENT REQUIRED FOR PROCEDURE 3E

Equipment
Required
Atmospheric

Atmospheric Conditioning:

- Humidity recording apparatus complying with of the apparatus section of ASTM D 4332-01.
- Temperature recording apparatus complying with the apparatus section of ASTM D 4332-01.

Optional Atmospheric Conditioning

- Chamber and Control apparatus complying with the apparatus section of ASTM D 4332-01.

Equipment
Required
Shock

The following alternatives are acceptable for the equipment required for the Impact Test:

Type of Shock Test	Equipment	In compliance with the apparatus section of:
Incline Test	Incline impact tester (conbur)	ASTM D 880-92(02)
Horizontal Test	Horizontal impact test system	ASTM D 4003-98

Equipment
Required
Compression

The following alternatives are acceptable for the equipment required for the Compression Test:

Type of Compression Test	Equipment	In compliance with the apparatus section of:
Apply and Release Test	Compression test system	ASTM D 642-00
Apply and Hold Test	Compression test system	ASTM D 642-00
Apply and Hold Test	Weight and load spreader	NA

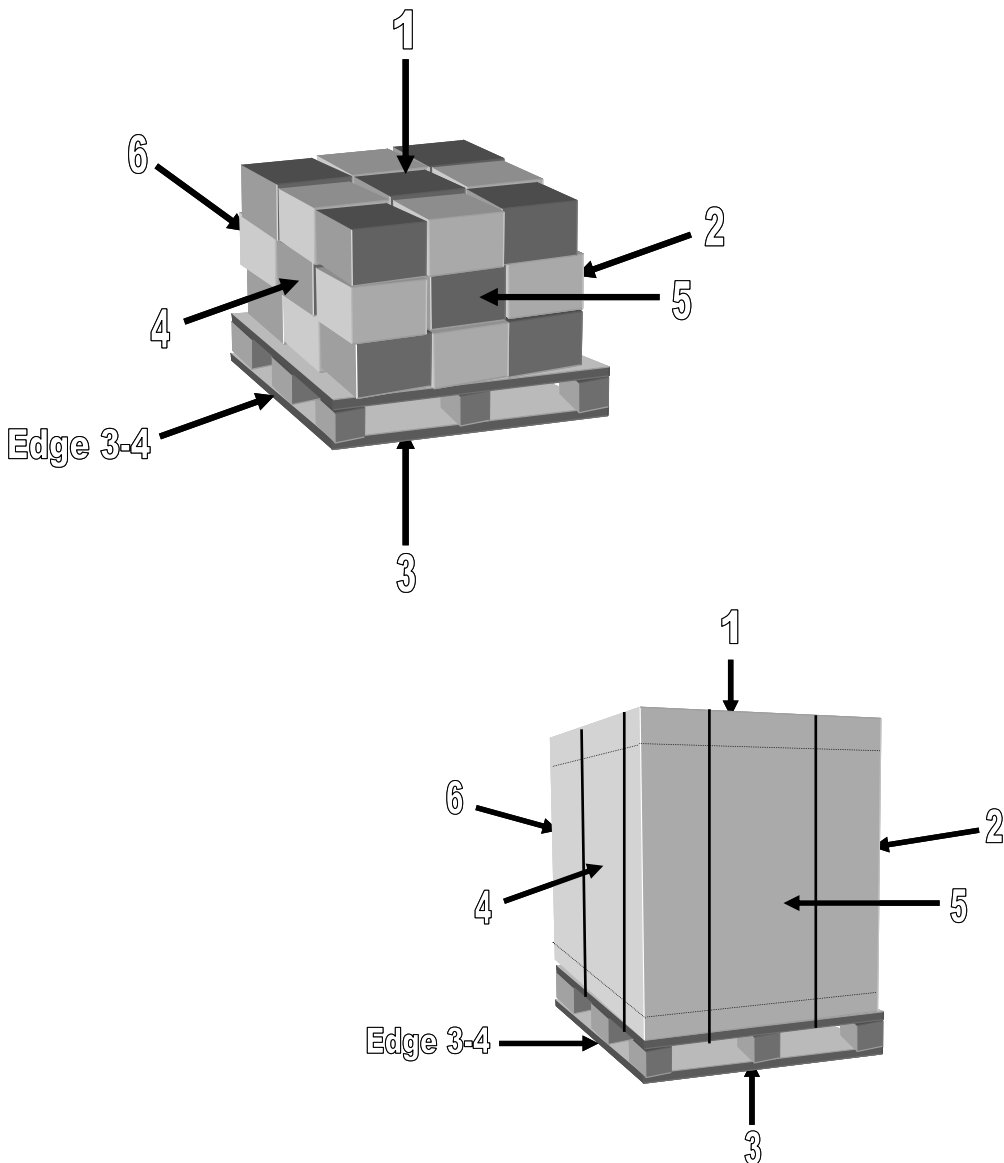
Equipment
Required
Vibration

Random Vibration Test:

- Random Vibration Test System complying with the apparatus section of ASTM D 4728-01.

BEFORE YOU BEGIN PROCEDURE 3E

Prior to beginning the tests identify the faces and edges according to the procedure below.

Step	Action
1	Place the unit load in its designed transport orientation.
2	Position one of the smallest width faces of the unit load directly in front of you.
3	<p>Identify faces according to the diagram below.</p>  <p>The top diagram shows a 3x3x3 cube of unit loads on a pallet. Arrows point to faces 1 (top), 2 (right), 3 (bottom), 4 (left), 5 (front), and 6 (back). The bottom diagram shows a single unit load on a pallet with similar face numbering.</p>
4	<p>Identify edges using the numbers of the two faces forming that edge.</p> <p>Example: Edge 3-4 is the edge formed by face 3 and face 4 of the unit load.</p>

BEFORE YOU BEGIN PROCEDURE 3E

Unit Load
Weight and Size
Measurement

You shall know the unit loads:

- gross weight in pounds (kg), **and**
- outside dimensions of Length, Width and Height (L x W x H) in inches (mm or m)

Before You Begin
Atmospheric
Conditioning

Required Preconditioning:

The packaged-product should be stored prior to climate conditioning at laboratory ambient temperature and humidity for twelve (12) hours.

Optional Conditioning Recommended: After the required precondition

To permit an adequate determination of packaged-product performance at anticipated atmospheric limits and where it is known that the atmospheric extremes are detrimental to the product, ISTA

- **Requires** the highest temperature and humidity limits shall be used, **but**
- **Recommends** that both the highest and lowest atmospheric conditions be used.

A separate 3E test sequence should be conducted following each atmospheric condition selected from the table below:

Anticipated Conditions	Time in Hours	Temperature in °C $\pm 2^{\circ}\text{C}$ (°F $\pm 4^{\circ}\text{F}$)	Humidity in %
Frozen or winter ambient	72	-29°C (-20°F)	uncontrolled RH
Refrigerated packages	72	5°C (40°F)	85% RH $\pm 5\%$
Controlled temperature	72	23°C (72°F)	85% RH $\pm 5\%$
Tropical (Wet) climate	72	38°C (100°F)	85% RH $\pm 5\%$
Tropical (Wet) then desert (Dry):	72 then 6	38°C (100°F) then 60°C (140°F)	85% RH $\pm 5\%$ then 30% RH $\pm 5\%$
Desert or summer ambient	72	50°C (120°F)	uncontrolled RH
User Defined High Limit	72	Based upon known conditions	Known conditions
User Defined Low Limit	72	Based upon known conditions	Known conditions
User Defined Cycle	72	Based upon known conditions	Known conditions

Before You Begin
Shock Testing**CAUTION:**

If the Unit Load:

- has a length twice the width **and**
- a center of gravity above the midpoint of the height.
- There is the possibility that Unit Load could tip over when testing one of the longest edges, **therefore**
- You may conduct the Rotational Edge Drop test on both the shortest edges.

Test the unitized load at a minimum of 42 inches per second (1.1 meters per second).

If any Test in the sequence is below the required 42 inches per second (1.1 meters per second) minimum, that sequence event must be repeated until it meets the minimum.

NOTE:

42 inches per second is equal to 3.5 feet per second.

BEFORE YOU BEGIN PROCEDURE 3E

CAUTION:

When using weights and a load spreader use extreme care to prevent injury.

NOTE:

Each of the formula has a numerical factor that compensates for other hazards that are not simulated in the test protocol.

Exception:

- If it is the product/s **and/or**
- The primary package/s that supports the load in a stack **and**
- Not the transport package that supports the load **and**
- The product/s and/or the primary package/s are not affected by **time, temperature or humidity**, then
- The compensating factor may be less than required.

Familiarity with the following formulas is required for unitized loads that will be warehoused for more than 48 hours prior to shipment:

Warehousing Compression (W)		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	W-AR-C	$W_t \times (S - 1) \times 3 \times 1.4$	$W_t \times (S - 1) \times 3 \times 9.8 \times 1.4$
Apply and Hold (AH) Test Force	W-AH-C	$W_t \times (S - 1) \times 3$	$W_t \times (S - 1) \times 3 \times 9.8$
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	W- AH - DW	$W_t \times (S - 1) \times 3$	$W_t \times (S - 1) \times 3 \times 9.8$
Where			
W	Warehouse Compression		
C	Compression Test System		
DW	Dead Weight and Load Spreader		
AR	Test Load for Apply and Release		
AH	Test Load Apply and Hold		
W_t	Gross weight of the unitized load		
S	Total number of unitized loads in a warehouse stack		
1	Represents the bottom unitized load		
1.4	Compensating factor for time of compression		
3	Compensating factor for a unitized load warehoused for more than 48 hours prior to shipment		
9.8	Metric conversion factor		

Continued

BEFORE YOU BEGIN PROCEDURE 3E

Familiarity with the following formulas is required:

Vehicle Compression (V)			
Unitized load height = 55 inches (1.4 m) or over		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	V-AR-C	$W_t \times 1.5 \times 1.4$	$W_t \times 1.5 \times 9.8$
Apply and Hold (AH) Test Force	V-AH-C	$W_t \times 1.5$	$W_t \times 1.5 \times 9.8$
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	V- AH - DW	$W_t \times 1.5$	$W_t \times 1.5 \times 9.8$
Unitized load height = less than 55 inches (1.4 m)		English Units	Metric Units
Compression Test System	Test Force	Pounds Force (lbf)	Newtons (N)
Apply and Release (AR) Test Force	V-AR-C	$W_t \times 3 \times 1.4$	$W_t \times 3 \times 9.8 \times 1.4$
Apply and Hold (AH) Test Force	V-AH-C	$W_t \times 3$	$W_t \times 3 \times 9.8$
Weight and Load Spreader	Test Load	Pounds (lb)	Kilograms (kg)
Apply and Hold (AH) Dead Weight Test Load	V- AH - DW	$W_t \times 3$	$W_t \times 3 \times 9.8$
Where			
V	Vehicle Compression		
C	Compression Test System		
DW	Dead Weight and Load Spreader		
AR	Test Load for Apply and Release		
AH	Test Load Apply and Hold		
W_t	Gross weight of the unitized load		
1.4	Compensating factor for time of compression		
1.5	Compensating factor for a unitized load with a of height 55 inches (1.4 m) or over		
3	Compensating factor for a unitized load that is less than 55 inches (1.4 m) in height		
9.8	Metric conversion factor		

Continued

BEFORE YOU BEGIN PROCEDURE 3E

Use the following table to determine which Load Force and what calculated test load to use in the Compression Test Block.

Step	Action	
1	Calculate a test force/load using the appropriate formula from the tables above as indicated in the table below:	
	Unitized Load with a height ...	Use the Formula for ...
	55 inches (1.4 m) or over.	Vehicle Force/Load - load height 55 inches (1.4 m) or over.
	Less than 55 inches (1.4 m).	Vehicle Force/Load - load height less than 55 inches (1.4 m).
2	Determine if the Unitized Load will be subjected to stacking in a warehouse for more than 48 hours before being shipped? <ul style="list-style-type: none"> • If Yes, then continue with the next Step. • If No, then Vehicle Force/Load determined in Step 1 will be used in the Compression Test Block. 	
3	Calculate a test force/load using the formula Warehousing Force/Load formula from the table above.	
4	Determine the test force/load to be used by performing the appropriate action as indicated in the table below:	
	IF the calculated Warehousing Force/Load from Step 3 is ...	Then use...
	Less than the calculated Vehicle Force/Load from Step 1	the Vehicle Force/Load calculated test load from Step 1 as the test load in the Compression Test Block.
	Equal to or greater than the calculated Vehicle Force/Load from Step 1	the Warehousing Force/Load calculated test load from Step 3 as the test load in the Compression Test Block.

BEFORE YOU BEGIN PROCEDURE 3E

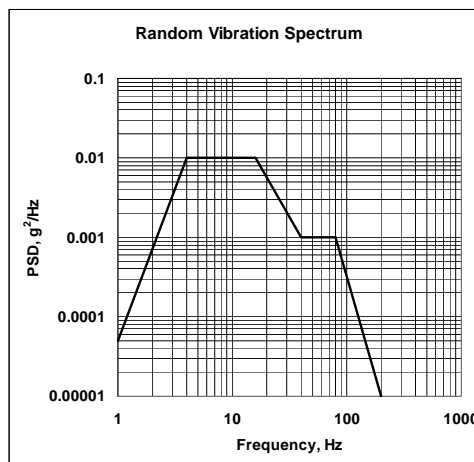
CAUTION:

A restraining device or devices shall be used with the vibration test system to:

- Prevent the test specimen from moving off the platform **and**
- Maintain test orientation of the packaged-product, **but**
- The restraining device or devices shall not restrict the vertical motion of the test specimen during the test.

The following breakpoints shall be programmed into the vibration controller to produce the acceleration versus frequency profile (spectrum) below with an overall G_{rms} level of 0.52

Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.00005
4.0	0.01
16.0	0.01
40.0	0.001
80.0	0.001
200.0	0.00001



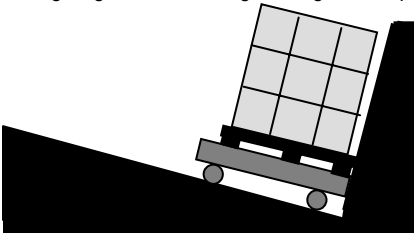
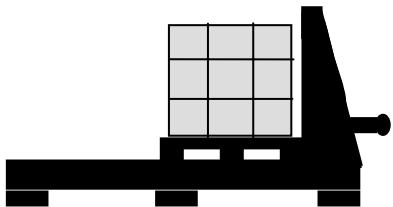
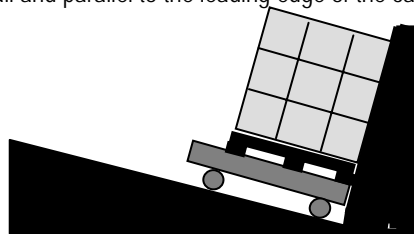
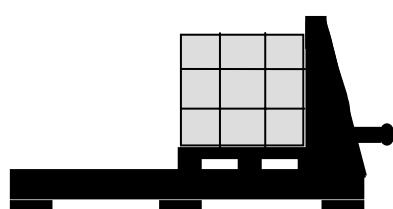
Estimate the anticipated total miles of the ground shipment the packaged-product may encounter during distribution to determine a test time from the table below:

Transport Miles	Transport Kilometers	Test Time (minutes)
Below 300	Below 500	30
300-600	500-1000	60
600-900	1000-1500	90
900-1200	1500-2000	120
1200-1500	2000-2500	150
Above 1500	Above 2400	180

TEST SEQUENCE FOR PROCEDURE 3E

The test blocks that follow contain tables that indicate the required steps for each test in the procedure.

TEMPERATURE AND HUMIDITY	
Step	Action
1	The packaged-product should be stored at laboratory ambient temperature and humidity for twelve (12) hours.
2	Is optional conditioning going to be performed? <ul style="list-style-type: none"> • If Yes, go to Step 6. • If No, go to the next Step.
3	Record the ambient laboratory temperature and humidity when testing starts.
4	At the end of all testing record temperature and humidity.
5	Go to the next First Shock Test Block.
6	Select an anticipated condition from the Before You Begin Block.
7	Check the conditioning apparatus to insure that the temperature and humidity are at the required levels.
8	Place the packaged-product in the conditioning.
9	At the completion of the required conditioning time remove the packaged-product from the conditioning apparatus.
10	Record the ambient laboratory temperature and humidity when testing starts. Go to the First Shock Test Block and perform the remaining test sequence as quickly as possible.

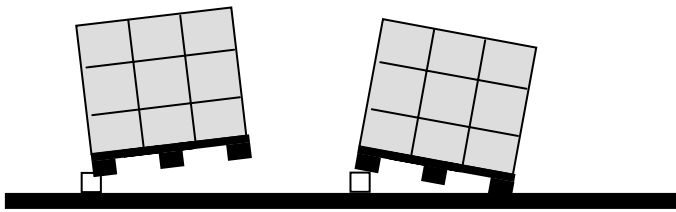
IMPACT TEST	
Step	Action
1	Do the packaged-products overhang the edge of the pallet? <ul style="list-style-type: none"> • If Yes, then go to Step 3. • If No, then continue with the next Step.
2	Center the unitized load on the carriage with the pallet edge flat against the backstop or sail and parallel to the leading edge of the carriage and go to Step 4. <div style="display: flex; justify-content: space-around; align-items: center;">   </div>
3	Center the unitized load on the carriage with the vertical face of the unitized load flat against the backstop or sail and parallel to the leading edge of the carriage. <div style="display: flex; justify-content: space-around; align-items: center;">   </div>

Continued

TEST SEQUENCE FOR PROCEDURE 3E

4	Test the unitized load at a minimum of 42 inches per second (1.1 meters per second). If any Test in the sequence is below the required 42 inches per second (1.1 meters per second) minimum, that sequence event must be repeated until it meets the minimum. Follow the sequence in the table below.		
	Sequence #	Orientation	Specific face
	1	Face	one of the smallest vertical faces
	2	Face	opposite small vertical face
	3	Face	one of the largest vertical faces
	4	Face	opposite large vertical face
5	Impact testing is now complete. Go to the Second Shock Test Block.		

Second Shock Test Block

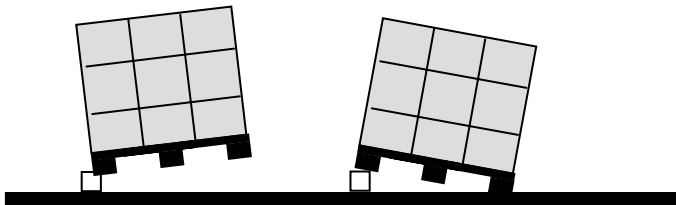
ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the unitized load onto a flat, rigid surface such as steel or concrete.
	2	Support any face 3 edge with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width. See CAUTION Statement on Page 5.
	3	Support one of the shortest face 3 edges with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width. Then go to Step 5.
	4	Support any face 3 edge with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width.
	5	Lift the opposite face 3 edge to 8 inches (200 mm) off the surface.
	6	Release the edge so that it falls freely onto a flat, rigid surface.
		
2	<p>Does the Unit Load have a length equal to or greater than twice the width and a center of gravity above the midpoint of the height?</p> <ul style="list-style-type: none"> • If Yes, then go to Step 4. • If No, then continue with the next step. 	
3	Repeat Step 1 on one of the face 3 edges radiating 90° from the edge just tested in Step 1 Sequence 4. Then go to Step 5.	
4	Repeat Step 1 on the face 3 edge opposite the edge just tested in Step 1 Sequence 3. Then go to the next Step.	
5	All testing is now complete. Go to the Compression Test Block.	

TEST SEQUENCE FOR PROCEDURE 3E

COMPRESSION		
Step	Action	
1	Testing is to be conducted using the test force or load from the Before You Begin Test Block and by performing the appropriate action as indicated in the table below:	
	IF the testing equipment to be used is a ...	THEN go to ...
	Compression Test System	Step 2.
	Weight and load spreader	Step 7.
2	Center the packaged-product with face 3 resting on the lower platen of the compression tester.	
3	Start the test machine and bring the platens together at the rate of one-half (0.5) inch (13 mm) per minute.	
4	Perform the appropriate action as indicated in the table below:	
	IF the compression test is a...	THEN ...
	Apply and Release Test	Increase the force until it reaches the AR Test Force value determined in the Before You Begin Compression Testing block . Then go to Step 5.
	Apply and Hold Test	Increase the force until it reaches the AH Test Force value determined in the Before You Begin Compression Testing block . Then go to Step 6.
5	Release the force. Go to Step 11.	
6	Maintain the force for one (1) hour, and then release the force. Go to Step 11.	
7	Place the packaged-product with face 3 resting on a smooth, flat, rigid surface.	
8	Place a rigid load spreader that is larger than the top face of the test specimen on the packaged-product.	
9	Add weight to the load spreader to bring the total weight up to the DW-AH Test Load determined in the Before You Begin Compression Testing block and maintain for one (1) hour.	
10	Remove the weight and load spreader.	
11	<p>Is the product damaged or the package degraded according to the Product Damage Tolerance and Package degradation Allowance?</p> <ul style="list-style-type: none"> • If Yes, then the packaged-product has failed the test, go to the Test Report. • If No, then go to the Vibration Test Block. 	

RANDOM VIBRATION	
Step	Action
1	Put the packaged-product on the vibration table so that face 3 rests on the platform.
2	Start the vibration machine to produce the random vibration spectrum indicated in the Before You Begin Block .
3	Stop the vibration testing at the end of the test time indicated in the anticipated transport miles chart in the Before You Begin Block .
4	Inspection of the packaged-product for visible damage is allowed, provided inspection does not alter, in any way, the current condition of the package or the condition or position of the product(s).
5	Testing is now complete. Go to the Third Shock Test Block.

TEST SEQUENCE FOR PROCEDURE 3E

ROTATIONAL EDGE DROP		
Step	Action	
1	Perform a rotational edge drop. Follow the sequence in the table below.	
	Sequence #	Action
	1	Place the unitized load onto a flat, rigid surface such as steel or concrete.
	2	Support any face 3 edge with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width. See CAUTION Statement on Page 5.
	3	Support one of the shortest face 3 edges with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width. Then go to Step 5.
	4	Support any face 3 edge with a timber or support 3.5 to 4.0 inches (90 to 100 mm) in height and width.
	5	Lift the opposite face 3 edge to 8 inches (200 mm) off the surface.
	6	Release the edge so that it falls freely onto a flat, rigid surface.
		
2	Does the Unit Load have a length equal to or greater than twice the width and a center of gravity above the midpoint of the height? <ul style="list-style-type: none"> • If Yes, then go to Step 4. • If No, then continue with the next step. 	
3	Repeat Step 1 on one of the face 3 edges radiating 90° from the edge just tested in Step 1 Sequence 4. Then go to Step 5.	
4	Repeat Step 1 on the face 3 edge opposite the edge just tested in Step 1 Sequence 3. Then go to the next Step.	
5	All testing is now complete. Go to the Test Report Block.	

TEST REPORT FOR PROCEDURE 3E

The packaged-product has satisfactorily passed the test if, upon examination, it meets the Product Damage Tolerance and Package Degradation.

ISTA Certified Testing Laboratories:

- Should file a test report on all ISTA Test Procedures or Projects conducted.
- Shall file a test report on all ISTA Test Procedures or Projects conducted to obtain Transit Tested Package Certification or Acknowledgement.

For additional information, refer to *Guidelines for Selecting and Using ISTA Procedures and Projects*.

ISTA Transit Tested Program

The ISTA Transit Tested Certification Mark as shown is a:

- registered certification mark **and**
- can only be used by license agreement **and**
- by a member of the International Safe Transit Association.

When a member prints this certification mark on a packaged-product with their license number they are showing their customer and the carrier that it has passed the requirements of ISTA preshipment testing.



In order to maintain its certified status and eligibility for identification with the TRANSIT TESTED Certification Mark, each packaged-product must be re-tested whenever a change is made in the:

- Product **or**
- Process **or**
- Package.

Changes in the product include changes in:

- Design **or**
- Size **or**
- Materials.

Changes in the process include changes in:

- Manufacturing **or**
- Assembly **or**
- Filling.

Changes in the package include changes in:

- Configuration **or**
- Dimensions **or**
- Weight **or**
- Materials **or**
- Components.

As a quality control procedure, packaged-products should be re-tested frequently, for example, yearly.

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